DWR OROVILLE FACILITIES RELICENSING PROJECT
(FERC Project No. 2100)

STUDY #1E: FEATHER RIVER TEMPERATURE MODEL DEVELOPMENT

December 12, 2001

1.0 INTRODUCTION/BACKGROUND

Temperatures in the Lower Feather River are very important for both agricultural interests and fishery habitat. Rice agriculture production requires temperatures that are warm enough for germination and growth. The fisheries that are supported within the Feather River downstream of the Oroville Reservoir require cooler temperatures for optimal habitat conditions. Analysis of operational alternatives that impact the temperature regime in the Lower Feather River will be very important in the relicensing process.

2.0 STUDY GOAL(S) AND OBJECTIVE(S)

The goal of this study is to develop a temperature model for the Lower Feather River that can simulate water temperature from the Oroville Dam downstream through the area of influence of the river. Simulation of other water quality constituents such as DO and pH are not considered in the model development process. Initial co-ordination efforts have indicated that these issues are not of concern at this time.

If these issues become of concern later in the process the model developed under this study plan may not be appropriate for use and additional model development may be required

3.0 RELATIONSHIP OF THE STUDY PLAN TO RELICENSING PROJECT PROCESS/PURPOSE AND NEED FOR THE STUDY

RELATIONSHIP OF THE STUDY PLAN TO RELICENSING PROJECT PROCESS

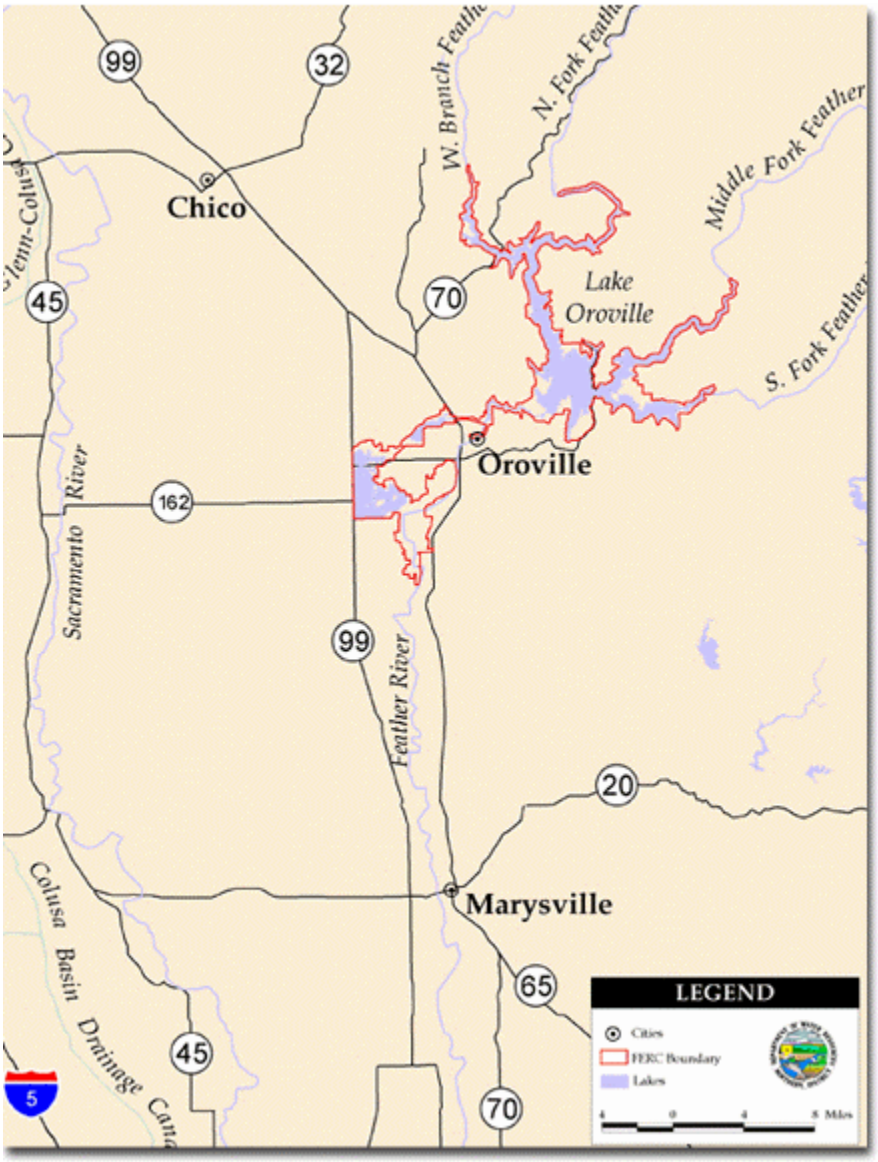
In order for the Oroville facilities to obtain a new license the Federal Energy Regulatory Commission (FERC) requires water quality certification from the State Water Quality Control Board (SWRCB). The certification requires that SWRCB determine that the project complies with the water quality requirements of the Central Valley Water Resource Control Board (CVWRCB) Basin Plan (SPW1, 01).

Purpose and Need for the Study

The purpose of this study is to develop a tool that can be used to evaluate the temperature impacts of operational alternatives and benchmark studies in the Lower Feather River. The temperatures in the Feather River are very important for both the agricultural diversions for rice growth, and for the instream cold water fishery.

4.0 SCOPE – STUDY AREA

The study area includes the Feather River downstream of the diversion dam to its confluence with the Sacramento River.



5.0 GENERAL APPROACH

This study will evaluate potential models and tools that could be used to develop a temperature model of the Lower Feather River. The resulting model will be capable of simulating temperatures throughout the Feather River.

Detailed Methodology and Analysis Procedures

Task 1 – Determine the model capability requirements

- Evaluate study plans and potential data requests from other work groups and/or regulatory agencies to determine desired model outputs
- Decide on the model complexity needed for the study (1-D, 2-D, 3-D).

Task 2 – Gather and Evaluate Existing data

Typical Input Data Needed to calculate the heat budget in river models:

- Solar radiation
- Dry and Wet bulb air temperatures
- Wind speed
- Atmospheric pressure
- Flow

Existing data on the Feather River includes:

- Temperatures at inputs to the river
- Temperatures at different monitoring stations between the Oroville Reservoir and the confluence with the Sacramento river
- Channel characteristics
- Year type-flows
- Meteorology conditions

Task 3 – Identify/select existing models/modeling tools

RMA-10 (Cook and Orlob, 2000)

RMA-10 can be used as a one, two or three-dimensional finite-element, hydrodynamic and water quality modeling tool. A 1-D temperature model of the Feather River downstream of the Fish Barrier Dam to the Sacramento River has been developed by UC Davis utilizing RMA-10. An empirical relationship between release flows and temperatures and water temperatures was developed for the Robison Riffle. Robinson riffle is a compliance point for the management of steelhead trout and spring run Chinook salmon, both federally listed species. This model operates on an hourly timestep and has been applied downstream of the Fish Barrier Dam to the Sacramento River.

HEC-5Q (USACE-HEC 1987c), (Deas and Lowney, 2001)

The Corps of Engineers developed a daily time step model of the Sacramento River Basin, including the Feather River using the HEC-5Q modeling tool. The model was used for instructional purposes by the Corp in preparation of their Training Document 24. The Hec-5Q modeling tool used simulates a one-dimensional, vertical temperature distribution for reservoirs; and a one-dimensional, longitudinal distribution for rivers. Reservoir-river simulations can be processed in a single run and includes comprehensive operations logic to accommodate operations (e.g. flood control, hydropower production)

QUAL2E

QUAL2E is a one-dimensional steady state flow model capable of simulating diurnal variations in water temperature. It operates on an hourly timestep has been applied to the Feather River (Deas and Lowney, 2001).

EXAMPLES OF OTHER MODELING TOOLS

- **WQRRS** (USACE-HEC 1986), (Deas and Lowney, 2001)
    - Model was used on the North Fork of the Stanislaus River (Smith, 1981), and Shasta and Trinity reservoirs (Orlob et al. 1993) and Meyer and Orlob, 1994) to develop relationships between upstream reservoirs and downstream river temperature effects.
    - Developed by the ACE
    - Can also be used as a reservoir and river temperature model
    - Reservoir-river simulations must be processed separately
    - One-dimensional, vertical temperature distribution for reservoirs; one-dimensional, longitudinal distribution for rivers.
    - Hourly timestep
    - Includes broad range of water quality and ecological processes

- **RMA** (Deas and Lowney, 2001)
    - Versions 2 and 11 predict flow and temperature, respectively
    - This model generates hourly predictions
    - Both versions are one-dimensional
    - They model both reservoirs and streams
    - They have been applied to the Sacramento and Feather rivers, and Keswick reservoir (Deas et al., 1997, Jensen et al., 1999)

- **MIKE-11**
    - Simulates rivers and reservoirs
    - Dynamic, one dimensional
    - Consists of many modules for specific modeling simulations which can be run in conjunction or separately

Task 4 – Model Development, Calibration and Verification

This task is the actual development of the Feather River Temperature Model.

Subtasks are:

- Select model/modeling tool for use
- Identify additional required data including type of data, quality of data and locations for collection. Specify monitoring needs including instrumentation and data collection processes required to obtain the data.
- Begin model development with existing data. Use assumed values for additional required data until it is collected.
- Perform model modifications, if required, for pumpback operations
- Calibrate/verify the model

The calibration/verification process will likely be the longest process involved in the study plan.

Task 5 – Perform Benchmark Oroville Release Temperature Analysis as required

Using the developed model perform the Feather River Temperature simulations required for the 2001 and 2020 Benchmark Studies.

6.0 RESULTS AND PRODUCTS/DELIVERABLES

RESULTS

This study plan will result in a temperature model capable of simulating temperatures for various operating scenarios in the Lower Feather River. It will output river temperature at various locations that will be utilized for impact analysis and/or as input to other modeling efforts.

Products/Deliverables

There will be two products of this study plan:

1. The product will be a Feather River temperature model that can simulate water temperatures at various locations within the Lower Feather River. The model will be fully integrated into the overall modeling scheme.
2. Simulated Feather River temperatures for the 2001 and 2020 benchmark studies for use in other analysis.

7.0 STUDY PLAN COORDINATION AND IMPLEMENTATION STRATEGY

Coordination with Other Resource Areas/Studies

This study will be coordinated with a number of other Engineering and Operation study plans:

Study Plan No. 1 - Model Development
Study Plan No. 1b - Local Operations Model Development
Study Plan No. 1c - Oroville Reservoir Temperature Model Development

Study Plan No. 1d - Thermalito Complex Temperature Model Development
Study Plan No. 2 - Modeling Simulation
Study Plan No. 6 - Feather River Temperature Regime Analysis

This study will operate with input form the Environmental Group.
Related Water Quality Study Plans: SPW1, SPW4, SPW6
Related Water Quality Issues: W1-W3, W9-W14, W16

Study Plan Tracking/Regulatory Compliance Requirements

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8.0 REFERENCES

Cook, C. B. and G.T. Orlob. 2000. DRAFT. *Numerical Estimation of Dynamic Water Temperature at Compliance Point Robinson Riffle.* UC Davis Feather River Computational Model. May, 2000

Deas M.L. and C.L. Lowney, 2001. Bay Delta modeling forum water temperature modeling review Central Valley. BDMF Temperature Review DRAFT.

United States Army Corp of Engineers – Hydrologic Engineering Center (USACE-HEC) 1987c. *Simulation of flood control and conservation systems: appendix on water quality analysis.* September

ATTACHMENTS (EXAMPLES)

NONE